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ABSTRACT

This paper describes the development of an adaptive multimedia learning environment that utilizes multimedia presentation techniques in its interface while still providing Internet connectivity for management and delivery purposes. The system supports the WWW as its addressing space but uses the local client areas to store media items expensive in terms of delivery time. Learning objects that provide frameworks for tasks and other summative assessment activities are stored on a server and delivered when required. The system supports link annotations in its adaptivity and employs an overlay student model with stereotyping when accessing the course content. (Contains 20 references.) (Author)

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Towards An Adaptive Multimedia Learning Environment: Enhancing the Student Experience

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Abstract: In this paper, we describe the development of an adaptive multimedia learning environment that utilises multimedia presentation techniques in its interface while still providing Internet connectivity for management and delivery purposes. The system supports the WWW as its addressing space but uses the local client areas tostore media items expensive in terms of delivery time. Learning objects that provide frameworks for tasks and other summative assessment activities are stored on a server and delivered when required. The system supports link annotations in its adaptivity and employs an overlay student model with stereotyping when accessing the course content.
Keywords: Educational multimedia, Adaptive Systems, Dynamic course generation, Student profiles.

1. Introduction

Large classes of students with different cultural and academic needs, coupled with the large range of individual approaches needed to deal with some of student learning issues raised above, have created problems for institutions catering for large numbers of students. A direction that a number of academic institutions have pursued is to place course materials in an on-line format. These materials can either replace pre-existing lectures/tutorials, or supplement it. Needless to say, a great variety of educational materials exist for possible reuse within the public domain and are available via their Universal Resource Locator (URL).

As has been pointed out [17, 18], the World Wide Web (WWW) provides a vehicle for the development of a learning environment with teaching structured towards the development of lifelong learning skills, and catering for the expectations and learning styles of students with a wide range of backgrounds. Early Australian examples of the use of the WWW in IT education abound. Boalch [3]provides an examination of the use of the WWW as a support medium for the delivery of a first year unit in Information Systems at Curtin University. He provides an evaluation of site utilisation and user feedback in the case where subject information and course details were provided on the WWW for students.

The Eklunds [8] examine the use of the WWW to supplement traditional IT teaching. They provide case studies of two examples of the re-structuring of traditional forms of IT course for Web-delivery. Jones [11] of Central Queensland University gives details of case study involving the design, presentation and evaluation of an undergraduate unit in Systems Administration taught completely via the WWW to on-campus and distance students.

However these and many newer systems that have been developed, rely on the low-level concept of interactivity (derived from a distance education paradigm) as the relationship between an individual student and text, and fail to use the technological interactivity, which is available. Common online learning environments often fail to maximise the potential of current multimedia resources. While the value of HTML pages and threaded discussions is acknowledged, they do not display the ability to adapt teaching material for the needs of individual students.

Multimedia objects within learning environments, provide a possible enhancement to the presentation of our on-line materials. Ricketts [16] describe the successful use of a hybrid CD/WWW presentation of course materials delivered in distributed mode where multimedia elements were provided on CD. The Herringtons [9] describe the benefits of multimedia within authentic assessment used in a teacher pre-service course. Looi et al [13] describe a collaborative WWW based system that provides for on-line communication and collaboration in the creation of multimedia artefacts for the WWW.

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Further, Jonassen et al [10] take the position that the true worth of multimedia and hypermedia might be obtained through the learner constructing knowledge via the use technology, rather than as a mode of delivery. Although the authors agree that the creation of multimedia and hypermedia artefacts is a powerful mechanism for individual learning, we do not discount the learning benefits attributed to the construction of different media views of content; we would argue that more individual learning styles could be accommodated.

Our view then of a learning environment is a domain populated with instructional items, presented as either multimedia or hypermedia objects with some addressing mechanism. This address might be a URL, or a directory path to a locally stored object. We use the term object to conform to the IEEE Learning Technology Standards Committee specification [7] for learning objects and further, agree with Wiley's [20] interpretation as 'any digital resource that can be reused to support learning'.

2. Adaptive Teaching

Various researchers who have experimented with adaptive teaching on the WWW have used techniques and principles derived from Intelligent Tutoring Systems (ITS) and particularly Anderson's rule based cognitive modelling [1]. Others have used Adaptive Navigation Support [4] to provide adaptive navigation through hypertext pages and thus developed adaptive textbooks for the tutoring, particularly, of software applications [4].

ITS and hypertext/hypermedia architectures provide different means of access to the educational materials contained within the knowledge domain. Hypermedia systems employ referential links that enable uses to typically follow non-sequential paths; organisational links (eg hierarchical) do provide some structuring that maps the expert's view of the domain. The pedagogical module of the ITS, provides information about the teaching process; this is non-existent in unstructured hypermedia systems and the user is generally free to explore the domain.

Adaptive systems couple the course model with a student model to provide adaptive navigation support. An adaptive system that makes available specific content (adaptive presentation) [4] provides students with a format of the new knowledge and skills appropriate to the students' level of understanding. Alternately, the system might provide links to appropriate content (link level adaption) [4]. Some systems also employ stereotyping within their student modelling structure. This appears to be an appropriate technique where distinct student groups with similar characteristics can be identified. However, any system based on stereotypes and preferences should be observable and thus editable by the user [12].

This paper presents techniques that are being developed to provide adaptivity within an introductory multimedia course[1], the aim of which is to provide the foundational knowledge and skills required to create and utilise a range of media items within multimedia presentations. The students undertaking the course come with a diverse range of knowledge and skills. The prototype developed is referred to as an Adaptive Multimedia Learning Environment (AMLE).

3. Implementation of AMLE

AMLE is essentially a collection of multimedia and hypermedia learning objects that are tagged with and address or path that enables the system to locate it. Learning objects, irrespective of their form and functionality, can then exist on remote servers, or indeed as local files. Our architecture is based upon a concept which has associated documents similar to [15]. Concepts can vary in presentation and can have hypertext/hypermedia links embedded within them; concepts are further grouped into sessions.

a. AMLE's Architecture

Two major decisions were undertaken in the early development of the prototype; firstly, to ensure that our items were consistent, we decided to use Adobe Acrobat pdf files as the default format; every concept has a

[1] http://multimedia.com.unisa.edu.au

version in this format. Associative links within these files can address the WWW in total, as well as the local file space. A player called a concept viewer to display concepts in this format, has been created.

The second decision taken was to keep media rich items on the local file system. The rationale for this was that the course offered initially would be administered each semester and the concepts would be static over this period; the time taken to deliver these materials would be greatly reduced. However, these still could be accessed through their URL if they existed on a server.

We have created an event driven interface (client) with Macromedia Director that provides hypermedia functionality, and a range of concept viewers to support different media formats. The main interface of the client connects to a remote server and accesses data defining both the course domain and the student profiling information. Thus, media files that constitute concepts and related activities are stored locally but administered over the WWW.

This WWW connectivity then provides the facility to monitor student usage and register assessment items. Lecturers/tutors interact with the course and student model through a standard WWW browser. Other learning objects that document assessment tasks and/or other course information are stored on the server side and accessed through either a WWW browser, or the main interface.

We have developed this multimedia learning system using Macromedia Director, ColdFusion, HTML and CGI Perl script that allow rapid prototyping; our main interface exists as a run time version while some tools and other applications can exist as source code. This is of significance in the initial course on offer because students can create multimedia artefacts that can be inserted directly into their workspace.

b. Interface details

The main interface provided for students to access the learning materials can be classified as a hybrid browser. It takes advantage of the multimedia development environment and enables a range of concept players to be used depending on content availability and student preference. These range from a concept being displayed as text formatted with HTML tags, to a concept being displayed as an acrobat pdf file, containing both text ual and graphical information. Video and audio formats can be utilised, along with appropriate animations. A range of other appropriate tools is provided in the interface to enhance the learning environment. For example, on-line tutorial groups can be established with the ability to discuss particular content-based issues.

The main interface is a windows environment that initially provides authenticated logging on/off facilities. Once identified and registered, the user is provided with the current sessio n, or the pre-test for that session if that is the first time that the student has accessed that session. From there, individual concepts can be accessed through a session player. Sessions are groupings of concepts and tasks that the domain expert has predefined for the course. This would correspond to the content provided in a weekly lecture(s) and associated tutorial/practical activities

It has been argued that link annotation [6] provides the user with extra information about the content available, enabling a more informed decision. Annotations are employed within the session viewer to indicate the content that a mouse click will provide. Where the system can infer that the student knows the concept or can perform the task, the session viewer is annotated accordingly. Links are not hidden so that the student is still able to follow it for revisional purposes.

c. Domain knowledge

Our course model is organised hierarchically into courses, sessions, concepts and documents. Sessions have been defined from concepts; sessions can have any number of concepts but a concept can only appear once within any session of a course. A concept consists of many documents; a document can be the content of a concept, its objective or some practical activity.

Our implementation is supportive of other possible domains of knowledge; the delivery system then is content independent. Tools for both the generation and subsequent use of the system have been investigated and an on-line database supporting both the student and course models, has been established. The placement of content into small modules, provides a mechanism for the flexible reuse. The course metadata is stored on a remote server along with the student profile information. We utilise an overlay model [5]and allow WWW access to this information.

To accommodate a range of students at various levels in their programmes, we pre-test at the session level. Another alternative considered and still to be investigated, might be to pre-test at the course level and infer knowledge from the results. For the practical components, students might be able to demonstrate the possession of some particular skills; this then needs to be handled manually and/or electronically.

The content of the delivery system is relatively static; that is, the teaching components that are delivered through a range of players accommodating text, pdf modules, video, audio, animations, etc. and any other media format that might become available in the future, are stored at the client side. The components of the delivery system involving the course structure and assessment pieces, student profiles and assessment results, data of those on-line, are stored on the server side.

Assessment at the concept level is based on a competency model; an evaluation is made of a student's understanding of a concept through questioning. Mastery of these randomly selected questions is reflected in the student profile that drives the adaptivity within the system. Where a concept is a skill or task, students may be asked to do something and have it registered manually; for example, the concept might be the scanning of an image. The concept might be demonstrated and the student asked to perform the task; completion of this task is manually registered. We distribute weekly tasks and longer summative assignments etc. through a server when required.

d. Instructional design

The hypertext/hypermedia learning environment constructed allows the instructor to employ a range of instructional methodologies. Constructivist principles underpin the environment and are supported; students create multimedia artefacts and place them into their workspace (or on the WWW), search out content, and satisfy authentic tasks. These in total, provide the macro level scaffolding [2] that allow the students to use particular content in different, albeit overlapping, contexts.

We are developing tools (search engine, glossary, concept map) to enable the user to search and access concepts directly as required. As students become more familiar with the environment, the instructional strategies may vary; for example, more problem based learning activities could be introduced. These activities might relate to the construction of multimedia artefacts, the acquisition of some understanding, or the establishment of a reasoned point of view with regards some ethical issue like copyright.

Student/student and tutor/student interactions are being established via online discussion groups which have the potential to support collaborative learning. This could be tutorial discussion groups with a number of their peers currently logged on addressing some weekly task. The number participating in these discussion groups is 4 by default; however, this is a system parameter and can be changed. Students are initially allocated on a first in, first allocated basis but any part of the student profile could be used for this purpose

e. Student and course administration

An on-line instructional management system has been constructed to establish courses based on concepts and sessions. An 'Administration Tool', enables course coordinators to create particular courses and direct content at particular groups. We have the potential to administer concurrent versions of a course directed at particular groups.

Lecturers and tutors have WWW access to our student model. Lectures can add/delete a tutorial group, add a new student, search for existing student, and update student's detail such as tutorial scores, assignment scores and exam scores. Tutors have access to update and search facilities of students' tutorial and assignment details.

AMLE uses and maintains student profiles that contain a summary of the student's competencies and other preference information. The coupling of the course model with the student profile has the potential to allow students to proceed at their own rate through the learning material. Further, the management system enables tutors to enter marks electronically and subsequently manage the assessment components of the course. Reporting mechanisms then cope with student, tutor and course co-ordinator requirements.

4. Current and Future Work

Our major concern has been to provide adaptivity and interactivity for our students since we recognise that our students' backgrounds and cultures contain a wide range of learning styles and expectations. We have used the on-line management components of the proposed system to maintain the assessment profiles of current students. However, the web-based materials that have been used thus far have not provided us with the granularity at the concept level to enable adaptive technologies. To this end, we have created a range of prototypes with varying interfaces to access the course model, and a number of players to display the content. These will be trialled with students in the near future.

A range of tools including tutorial chat facilities, notebooks and email, are provided in the interface for the users to take advantage of. Further work will involve the pre-testing of students and the full utilisation of student preference data collected.

The range a questions and question types that are randomly presented and marked by the system are a topic of current investigation. Results from these form the basis of the student's competency model and the subsequent adaptivity. Tutors are able to enter marks directly into the student competency profile for tasks where the competency for a concept can be demonstrated. The student's competency profile is further enhanced by an assessment profile that includes summative activities that could extend over a number of sessions. Both profiles are available to the students through a WWW browser interface that displays their current competency and assessment states.

A number of instructional methodologies and educational activities underpinned by a constructivist philosophy are being explored. So too are the different tools that will be available within the interface; for example, an online helpdesk that simulates a tutorial helpdesk situation where students pose questions to tutors who are currently on line

5. Conclusion

We are developing components of a multimedia learning environment that we feel have the potential to enhance on-line learning. The system presents course materials as concepts and adapts to prior knowledge through the use of link annotation. We have also introduced stereotypes into the overlay student model and have coupled this to different content presentations. Students can also specify the type of media presentation they prefer to use within the concept viewer. A range of other tools like search engines, indexes, helpdesk, tutorial groupings etc. will allow the lecturer to employ a range of instructional methodologies to satisfy the requirement of the course.

The dynamic components of the learning environment i.e. assessment, course structure, and other instructional artefacts. are stored on a remote server and are accessed through the WWW. Tutors have convenient on-line access to student groupings to enable marks entry.

We utilise two forms of assessment; namely formative assessment that includes the mastery (or competency) of particular concepts or skills conducted generally at a weekly level, and summative assessment that necessitates the use a range of knowledge/skills in its satisfactory completion. These are recorded within the overlay model of the student profile. Student preferences and settings, along with marks etc that make up the assessment profile of the students model, are available to the student for perusal and alteration.

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